CEMVP-OP-R (1999-5528-JKA) 22 November 2017

Draft MEMORANDUM

SUBJECT: *Interpreting Monitoring Well Data for Determining Potential In-Direct Hydrological Impacts to Wetlands*

1. **Introduction**

Should the NorthMet project be permitted and constructed, a component of monitoring for potential in-direct impacts to wetlands includes comparison of post-construction monitoring well data to baseline data, collection of which began in 2005. This necessitates a performance standard addressing how that data would be analyzed. Specifically, frequency and duration of deviations from baseline monitoring well data would be evaluated by the District Engineer to determine whether adaptive management, increased monitoring, and/or additional compensatory mitigation are warranted. The following is my recommendation:

> *For each individual monitoring well location, inundation/depth to the water table during the growing season shall remain within the minimum/maximum brackets (e.g., Figures 1-4) documented by baseline monitoring well data[1] when placed in context of hydrological conditions.[2,3] Deviations from baseline monitoring well data meeting one or both of the following criteria will be evaluated by the District Engineer to determine whether adaptive management, increased monitoring, and/or additional compensatory mitigation are triggered: (1) frequency: ≥2 growing seasons; and (2) duration: ≥14 consecutive days.*

This would be in addition to the measures described in the *Monitoring Plan for Potential Indirect Wetland Impacts—NorthMet Project* (Barr Engineering, Inc. 2016) and any subsequent iterations.

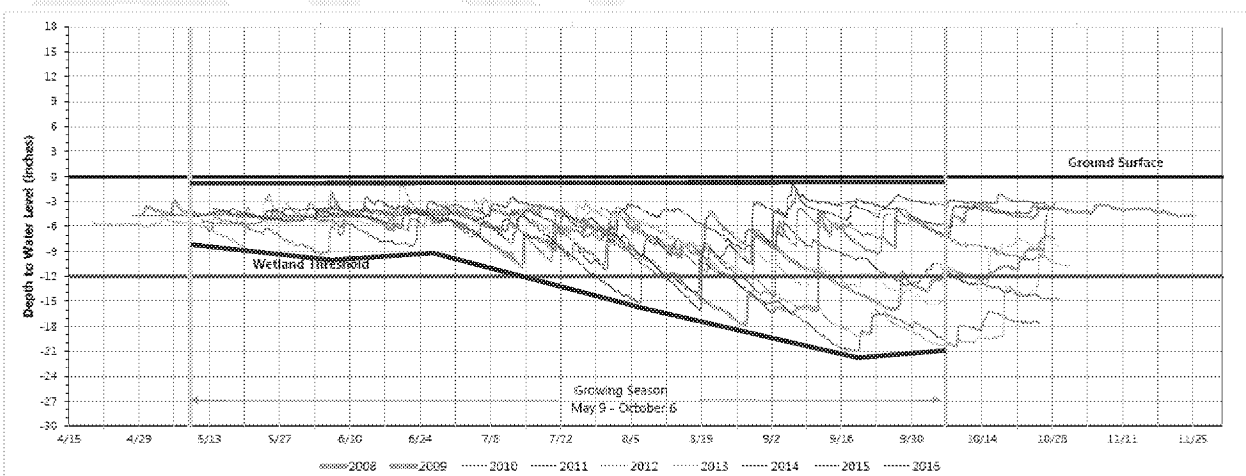

Figure 1—Red brackets define minimum/maximum range of water levels at Wetland Monitoring Well 10.

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[1] Barr Engineering, Inc. reports dated 2006, 2010 and 2017. See Literature Cited herein.

[2] Including 30-day rolling totals of precipitation, data from reference monitoring wells located outside of potential in-direct impacts, and the U.S. Drought Monitor (http://droughtmonitor.unl.edu).

[3] See discussion herein under 2.b.

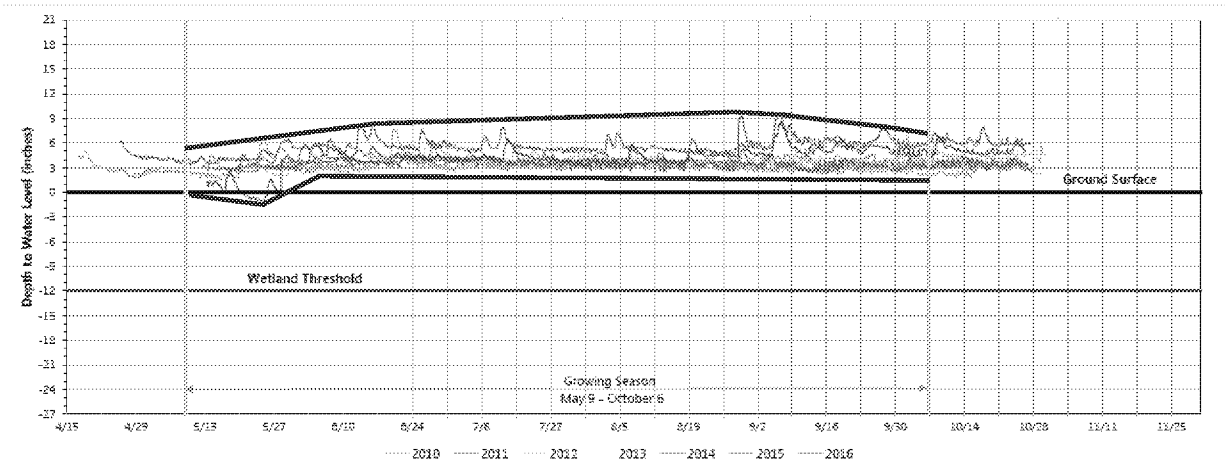

Figure 2—Red brackets define minimum/maximum range of water levels at Wetland Monitoring Well TB6.

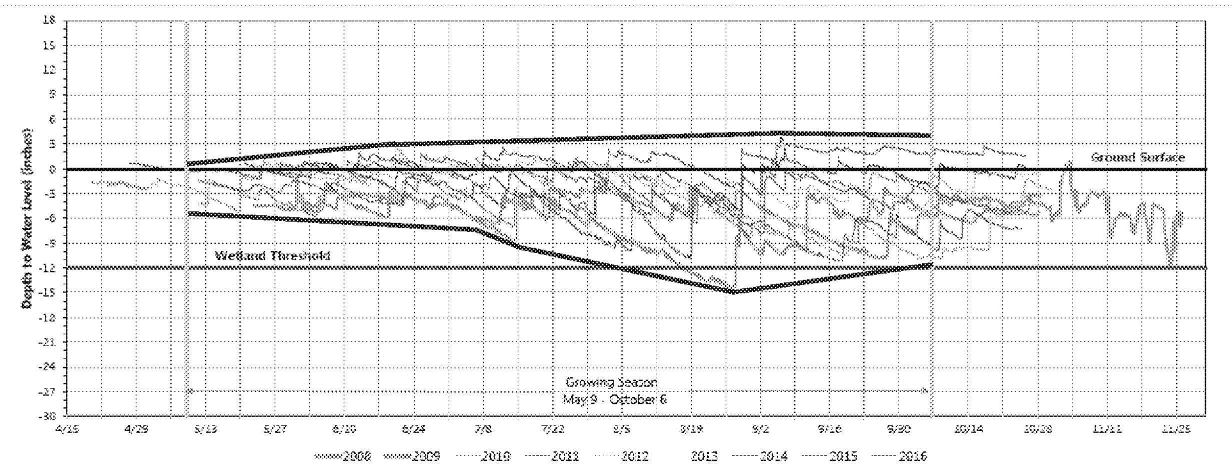

Figure 3—Red brackets define minimum/maximum range of water levels at Wetland Monitoring Well 21.

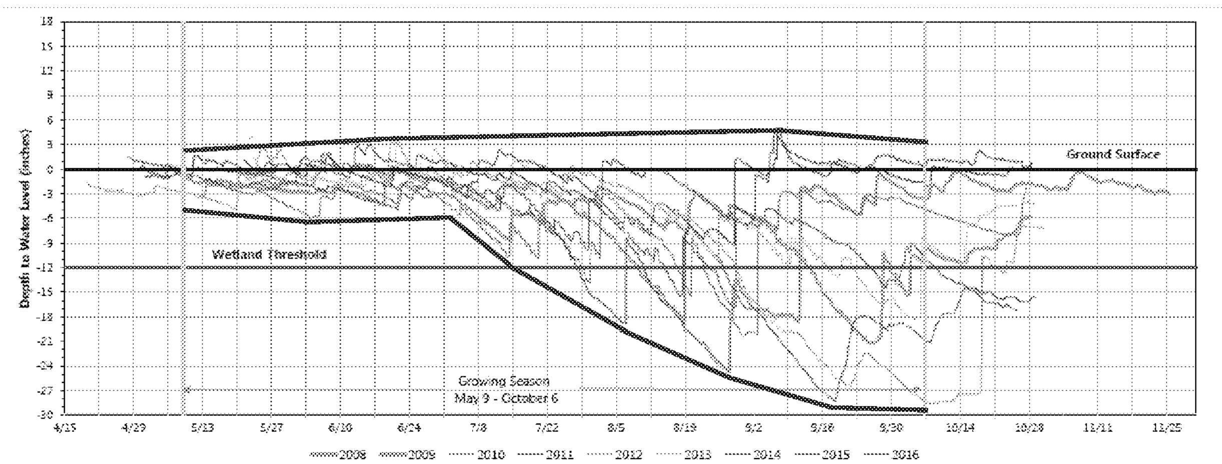

Figure 4—Red brackets define minimum/maximum range of water levels at Wetland Monitoring Well 22.

The intent is to identify any trends in changes to baseline wetland hydrographs. A deviation that occurs during one growing season is not a trend—thus, the specification for ≥2 growing seasons in the above performance standard. Similarly, a deviation lasting a few days does not establish a trend, while a deviation lasting ≥14 consecutive days is more indicative of a trend.

2. **Discussion**

a. <u>Types of Baseline Hydrographs</u>. Baseline monitoring well data illustrate two general hydrographs that characterize wetlands within the project site. One is inundation and/or a water table ≤12 inches below the soil surface throughout the growing season. Wetland Monitoring Wells 23 (Figure 5) and 4 (Figure 6) illustrate this category. The other is inundation and/or a water table ≤12 inches below the soil surface from the start of the growing season into July after which inundation/water table levels exhibit considerable variability and, at least in some years, drop more than 12 inches below the soil surface. Wetland Monitoring Wells 15 (Figure 7) and 6 (Figure 8) illustrate this category. In one case, the water table dropped 33 inches below the soil surface by late summer (Figure 8).

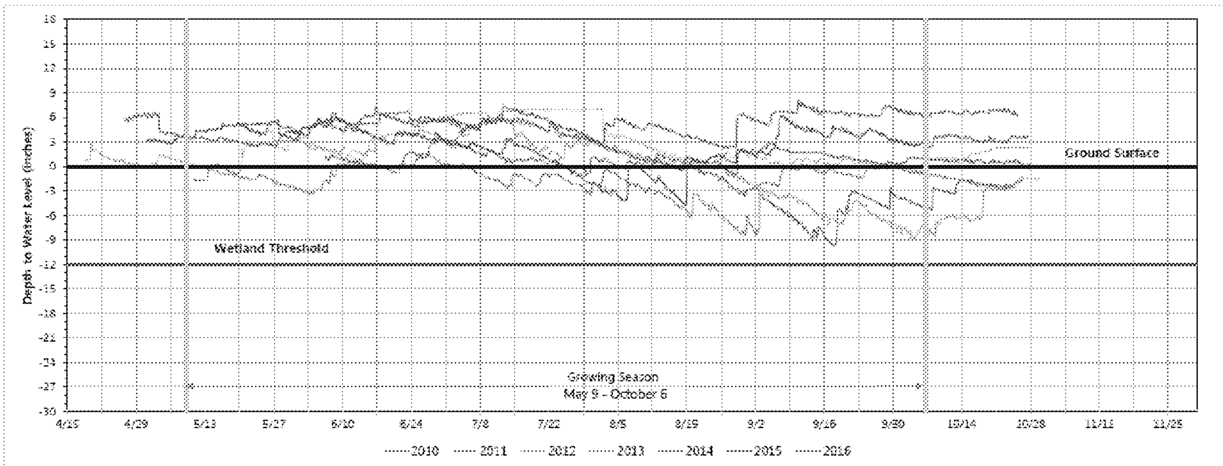

Figure 5—Wetland Monitoring Well 23.

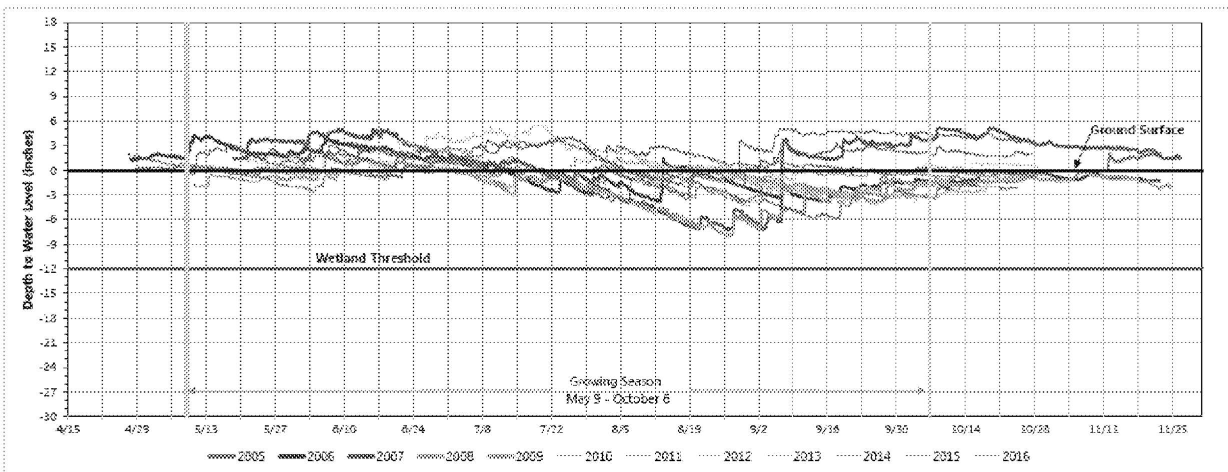

Figure 6—Wetland Monitoring Well 4.

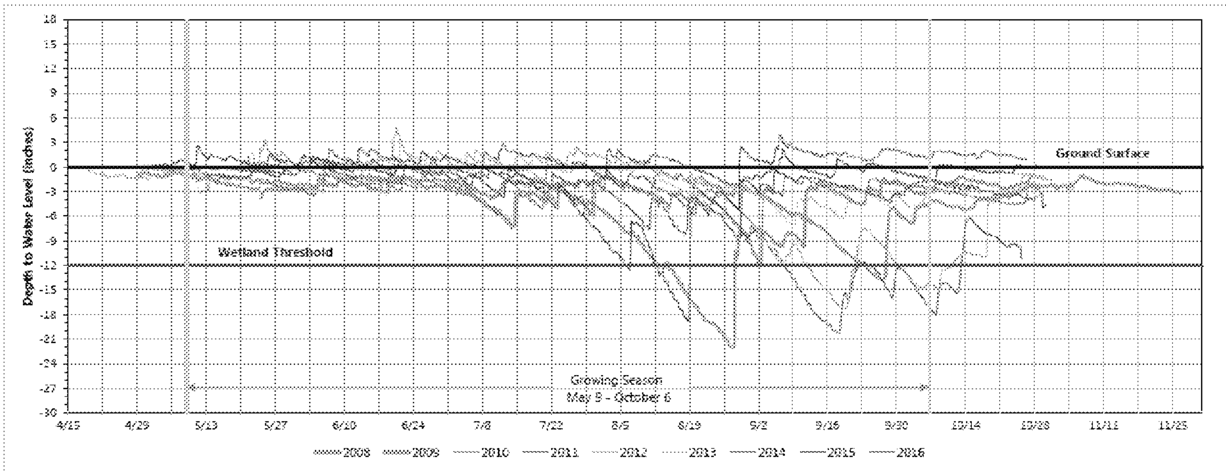

Figure 7—Wetland Monitoring Well 15.

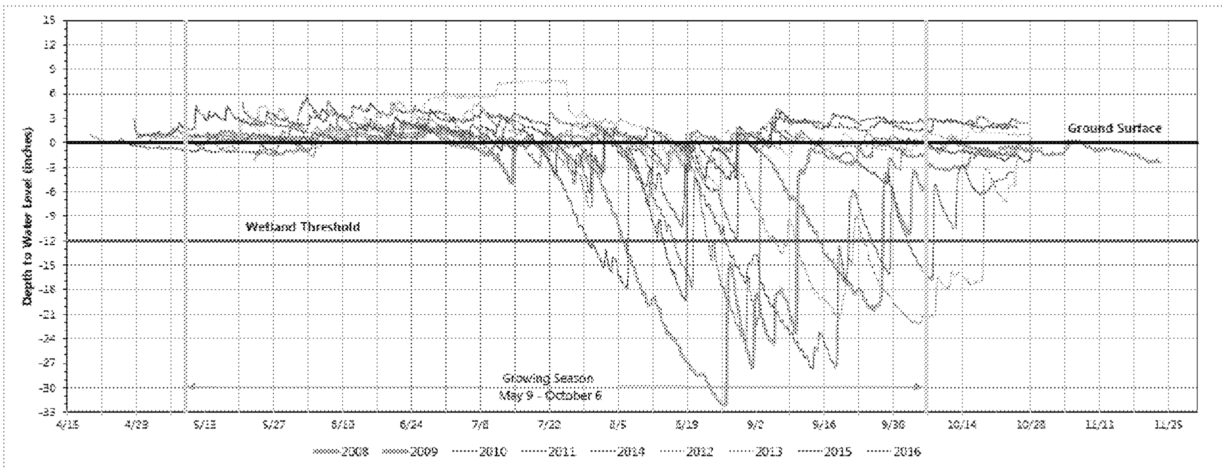

Figure 8—Wetland Monitoring Well 6.

b. In Context of Hydrological Conditions. An essential component of evaluating monitoring well data is placing those data in the context of hydrological conditions. Reports by Barr Engineering, Inc. (2006, 2010 and 2017) provide narratives, tables and figures describing hydrological conditions in terms of annual, monthly, and 30-day rolling totals of precipitation.

A key consideration is drought conditions. Analyses of post-project monitoring well data must be able to differentiate low water table levels that naturally occur due to drought conditions from low water levels that may be due to dewatering associated with mine operations. In Figures 6, 7 and 8 above, note the drop in water table depths during August and September of 2008, the lowest water table levels for any monitoring year at those particular monitoring well locations. Figure 9 illustrates 30-day rolling totals of precipitation in 2008 and the U.S. Drought Monitor for September 2, 2008 showing that the project area was within an area experiencing moderate drought conditions thereby providing an explanation for the low water table levels. If, during mine operations, similar low water table levels are recorded under similar drought conditions it would be considered within the normal range of variability for wetland hydrology at those monitoring well locations. If, however, similar low water levels are recorded during non-drought conditions, it would be considered an indicator of drawdown effects of mine operations unless a different explanation is identified and confirmed.

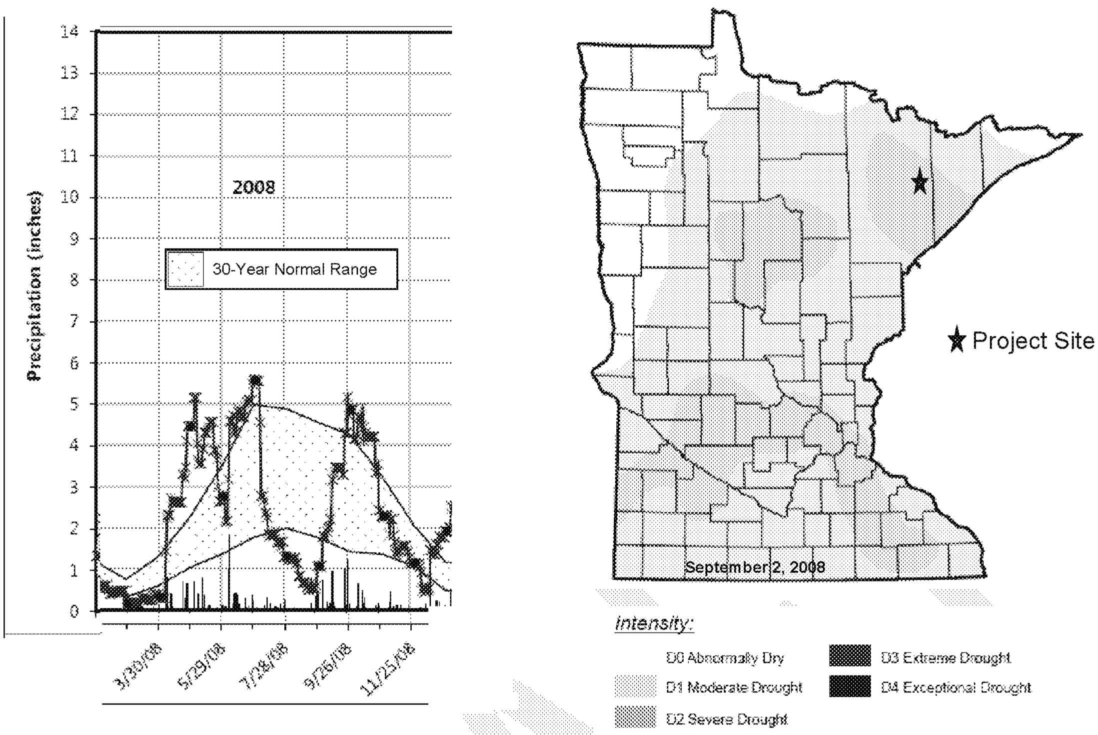

Figure 9

Alternatively, water levels during drought periods—as identified by the U.S. Drought Monitor—could be omitted, i.e., exclude the lowest water table readings from the minimum/maximum brackets. This approach is not recommended for two reasons. First, as stated above, drought periods are a natural occurrence—low water levels during drought periods are part of the natural variability in wetland hydrology. Disregarding valid data illustrating the full range of natural variability is not good science. Second, drought periods since 2005 were frequent, ranged from a few weeks to many weeks, and could come and go during the same growing season. Omitting water table levels recorded during drought periods would make for a more complex and potentially confusing performance standard to evaluate as a "trigger" for increased monitoring, adaptive management, and/or additional compensatory mitigation.

c. Interpreting Shorter-Term Monitoring Well Data. Thirty-two of the 61 wetland monitoring wells were installed in 2014 resulting in three growing seasons of data submitted to date with the 2017 growing season data to be submitted in the near future. These data provide a basis for determining the minimum/maximum brackets for performance standards, but are not as substantiated as data from well locations with seven or more growing seasons of monitoring. Precipitation during the 2014-2015-2016 growing seasons covered the gamut from wetter than normal to drought conditions (Figure 10). Early growing seasons in both 2014 and 2015 were wetter than normal followed by a steep drop to drier than normal then rebounding to normal (2014), or several drops into the low end of normal during mid-growing season resulting in drought conditions (Figure 11) followed by wetter than normal conditions in September to the close of the growing season (2015). In contrast, the 2016 growing season was wetter than normal for most of its duration except that the early growing was abnormally dry (Figure 11).

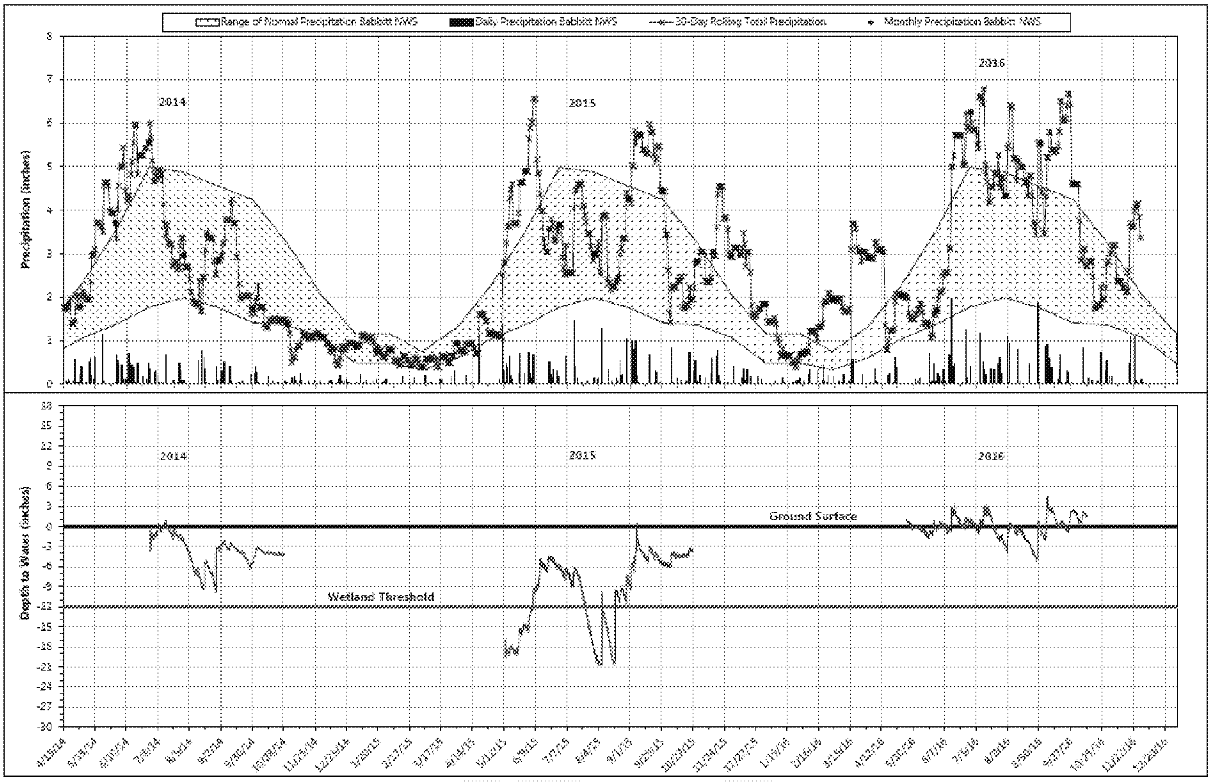

Figure 10—Thirty-day rolling totals of precipitation during 2014-2015-2016. Note in the lower graph how closely water levels in the wetland (blue lines) mirror peaks and valleys in the 30-day rolling totals (Wetland Monitoring Well 27).

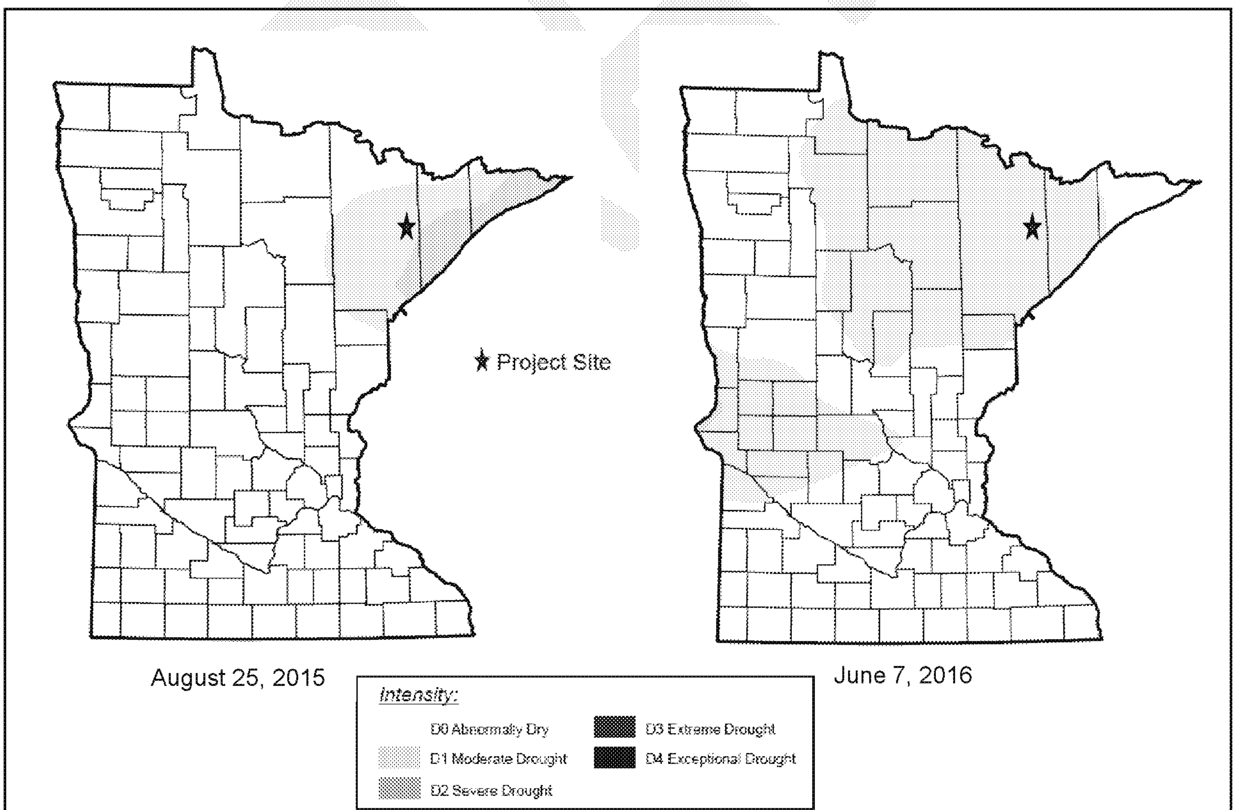

Figure 11

In the case of Wetland Monitoring Well 41 (Figure 12), water levels were relatively consistent in spite of the variable precipitation during 2014-2016—slightly above the soil surface to almost 9 inches below the soil surface throughout the growing season. Drops to the lowest water levels in August of both 2014 and 2015 correspond to mid-summer valleys in the 30-day rolling totals when precipitation ranged into the low end of normal or, for a brief duration, drier than normal (Figure 10). Minimum/maximum brackets for this monitoring well location are shown by Figure 13 with the caveat that water levels reaching 9 inches below the soil surface should be correlated with similar hydrological conditions, e.g., U.S. Drought Monitor (Figure 11).

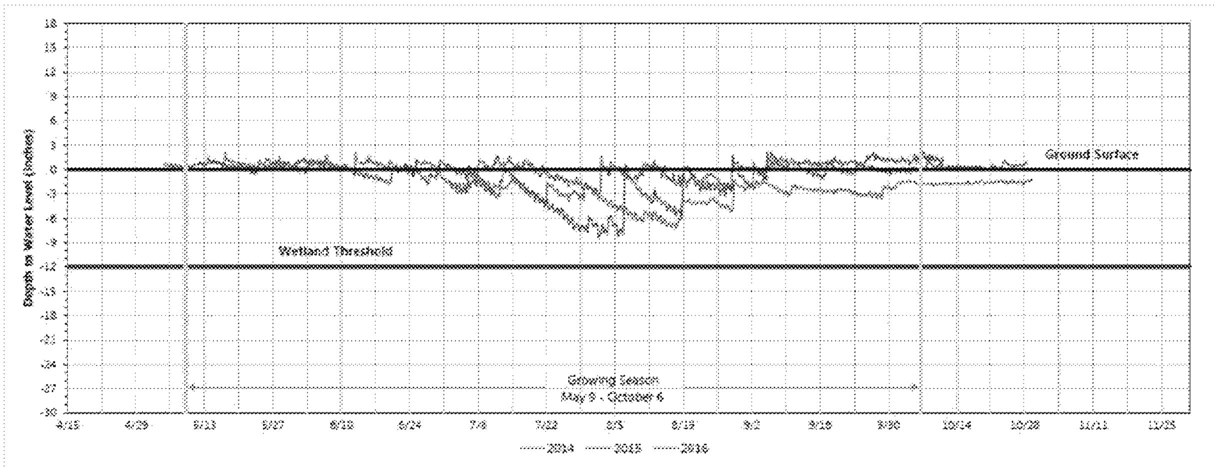

Figure 12—Wetland Monitoring Well 41.

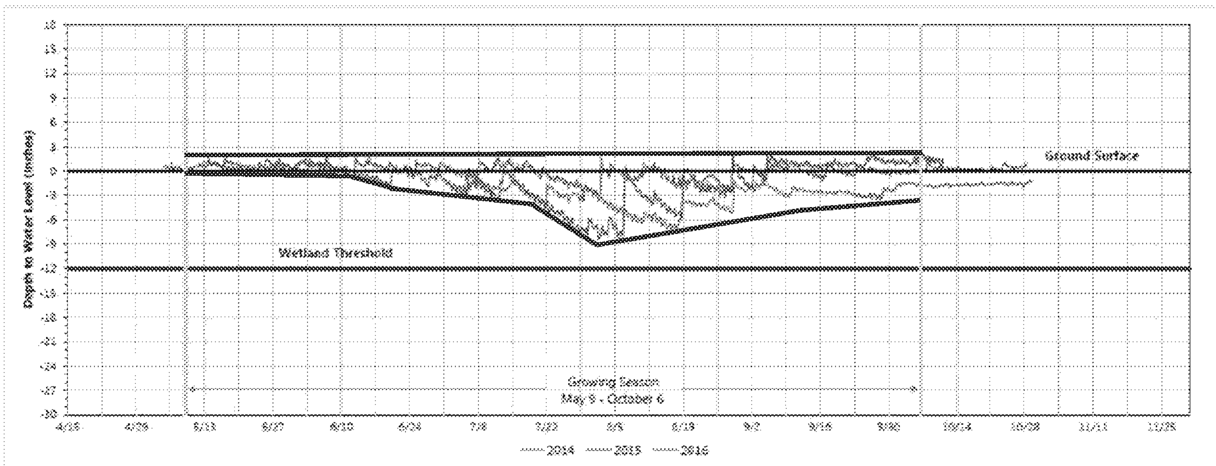

Figure 13—Minimum/maximum brackets (red lines) for Wetland Monitoring Well 41.

The hydrograph for Wetland Monitoring Well 28 (Figure 14) illustrates a much more varied response to hydrological conditions during 2014-2016. Reference wells and/or other monitoring well(s) of the same hydrograph type (see discussion in 2.a.) can be used to confirm an appropriate minimum/maximum range. In this case, Wetland Monitoring Well 24 is of the same hydrograph type (Figure 15), is in close proximity, is located within the same plant community type, and has been monitored for seven growing seasons thereby providing longer-term data on baseline conditions. Both monitoring well locations show similar responses, e.g., high water levels in 2016 and lowest water levels in August 2015.

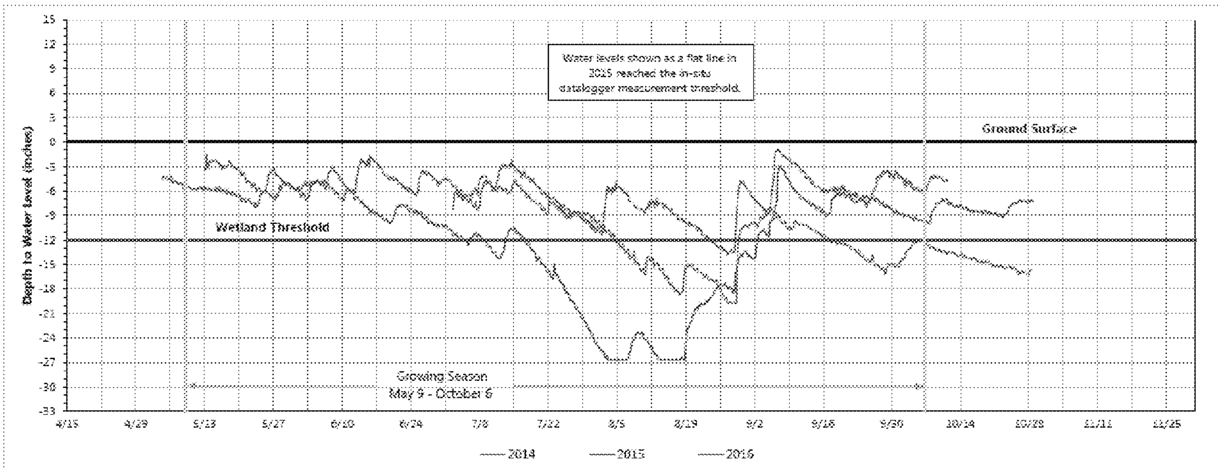

Figure 14—Wetland Monitoring Well 28.

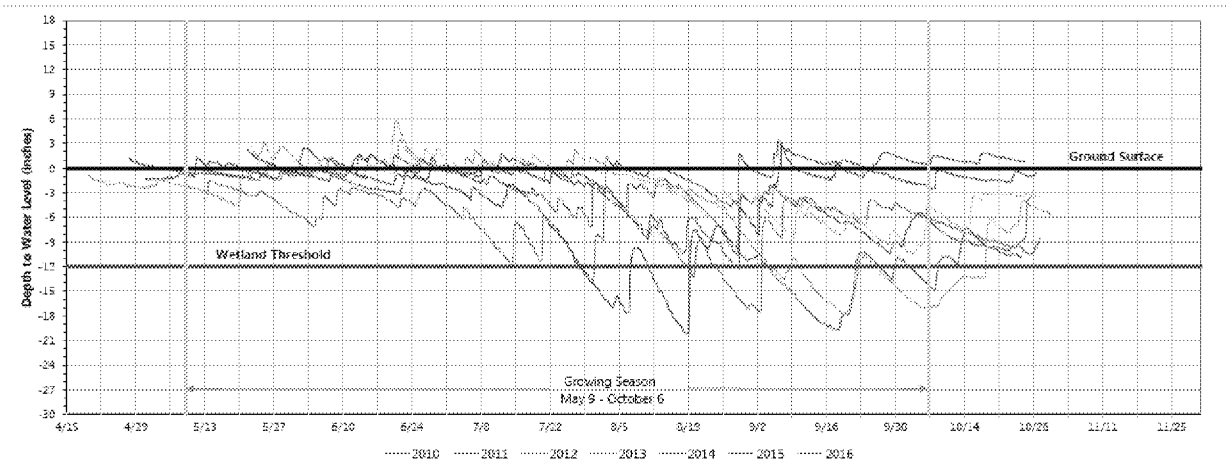

Figure 15—Wetland Monitoring Well 24.

Five reference monitoring wells have been established at locations outside of any potential in-direct effects. Water level responses to hydrological conditions recorded by these wells provides invaluable data for interpreting the timing and degree of rise or fall in water levels in monitoring wells located within areas that may experience in-direct effects due to mine operations. For example, in August-September of 2014 and 2015, water level responses in Reference Monitoring Well 3 (Figure 16) show drops in water table readings that correspond to those recorded at Wetland Monitoring Wells 24 (Figure 15) and 28 (Figure 14).

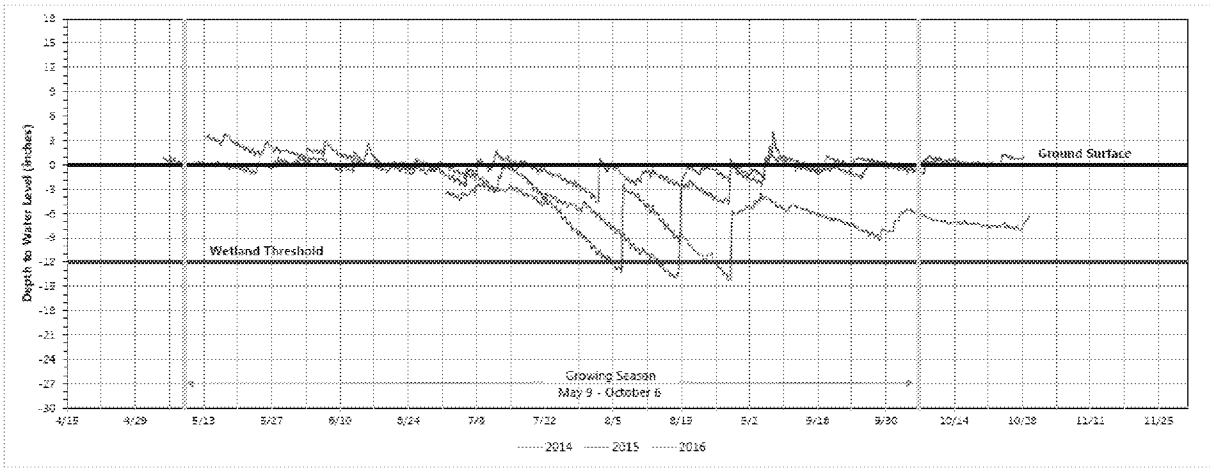

Figure 16—Reference Wetland Monitoring Well 3.

With the above knowledge, minimum/maximum brackets could be reasonably drawn as shown by Figure 17 with the caveat that low water table levels exhibited in August-September 2015 should be correlated—i.e., should only occur—under similar drought conditions. If, during mine operations, low water levels similar to August 2015 occur during a period of—for example—wetter than normal hydrological conditions, it would indicate that the low water levels were due to mine operations rather than natural variability in wetland hydrology unless a different explanation is identified and confirmed.

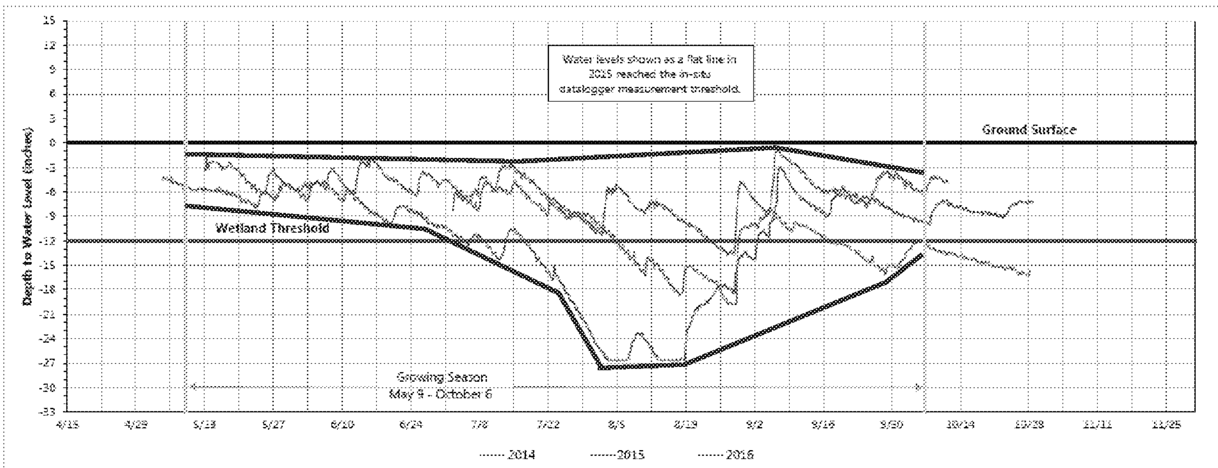

Figure 17—Red brackets define minimum/maximum range of water levels at Wetland Monitoring Well 28.

3. **Summary**

The performance standard proposed herein would provide a scientifically sound basis to evaluate whether in-direct wetland impacts occur by analyzing the following: (1) baseline (pre-project) monitoring well data including reference wetlands; (2) post-construction monitoring well data including reference wetlands; and (3) analyses of hydrological conditions (e.g., 30-day rolling totals of precipitation, U.S. Drought Monitor).

4. **Point of Contact.** Any questions on the above can be directed to me at 651-290-5371 or steve.d.eggers@usace.army.mil.

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Literature Cited

Barr Engineering, Inc. 2006. *Wetland Hydrology Study Report 2006.* Barr Engineering, Inc., Minneapolis, MN. 13 pp. plus tables and figures.

Barr Engineering, Inc. 2010. *Wetland Hydrology Monitoring Report 2007-2009.* Barr Engineering, Inc., Minneapolis, MN. 27 pp. plus tables and figures.

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Barr Engineering, Inc. 2017. *NorthMet Site Wetland Hydrology Monitoring Report Summary—2005-2016.* Barr Engineering, Inc., Minneapolis, MN. 56 pp. plus appendices, tables and figures.